C3.a #1
Review
Dec Doc

FINAL DRAFT **June 13, 2000**

Corydon Reservoir Total Maximum Daily Load Atrazine

1. Watershed Description and problem definition

The Corydon Reservoir is in the Upper Chariton Watershed, HUC 8: 10280201, the Iowa water body ID is IA 05-CHA-00620-L. The watershed drains approximately 2.63 square miles (1680 acres). The soils in the watershed are silty, clay loams that drain water poorly. There are approximately ten farmers in the watershed. The watershed is mainly row crop (52%) with about 335 acres of corn and about 540 acres of soy beans. The remaining area of the watershed is pasture and hayland (40%), woodlands (4%) and other (4%) (Sitzman, 2000).

In 1919 the dam was constructed for Corydon Reservoir. The reservoir was used as a drinking water source from 1919 to 1993. The reservoir covers a total area of 58 acres when completely full. Railroad tracks split the reservoir into two sections. The main area of the reservoir is 52 acres, and the remaining 6 acres are a shallow marsh-like area. The mean depth of the reservoir is approximately 5.9 feet. The volume of the reservoir is almost 15 million cubic feet when at the top of the spillway.

The reservoir is designated with class "A, B(LW) and C" beneficial uses. Waters which are designated as Class "A" are to be protected for primary contact recreation (for example, swimming and water skiing). Waters designated for Class "B(LW)" (Lakes and wetlands) are protected for wildlife, fish, aquatic and semi-aquatic life and secondary contact water uses. Rivers or lakes designated as Class "C" are protected as a raw water source of potable water, suitable for a drinking water supply. The city of Corydon no longer uses the reservoir as their water supply, but the drinking water standard must still be met because the class "C" use is an existing use.

Corydon Reservoir was assessed as not supporting its drinking water designated uses due to elevated levels of atrazine in the Iowa Department of Natural Resources (IDNR) 305(b) data base. The Iowa Department of Natural Resources listed Corydon Reservoir on their 1998 303(d) list of impaired waters for atrazine. The reservoir has a high priority for TMDL development. This listing was based on a study done by the United States Geological Survey (USGS) on Corydon Reservoir in the early 1990s (USGS, 1993). Iowa's water quality standard for atrazine is an acute value of 3 μg/l for the class "C" drinking water use.

2. Current Water Quality Conditions and Desired Endpoint

USGS monitored the reservoir from 1990-94 at several sampling points in the reservoir.

It was found that during June through September 1991, the average concentration of atrazine was 8μg/l. The observed seasonal, June- September, maximum in lake concentrations were plotted and used to predict the 1999 seasonal maximum concentration, see figure 1.

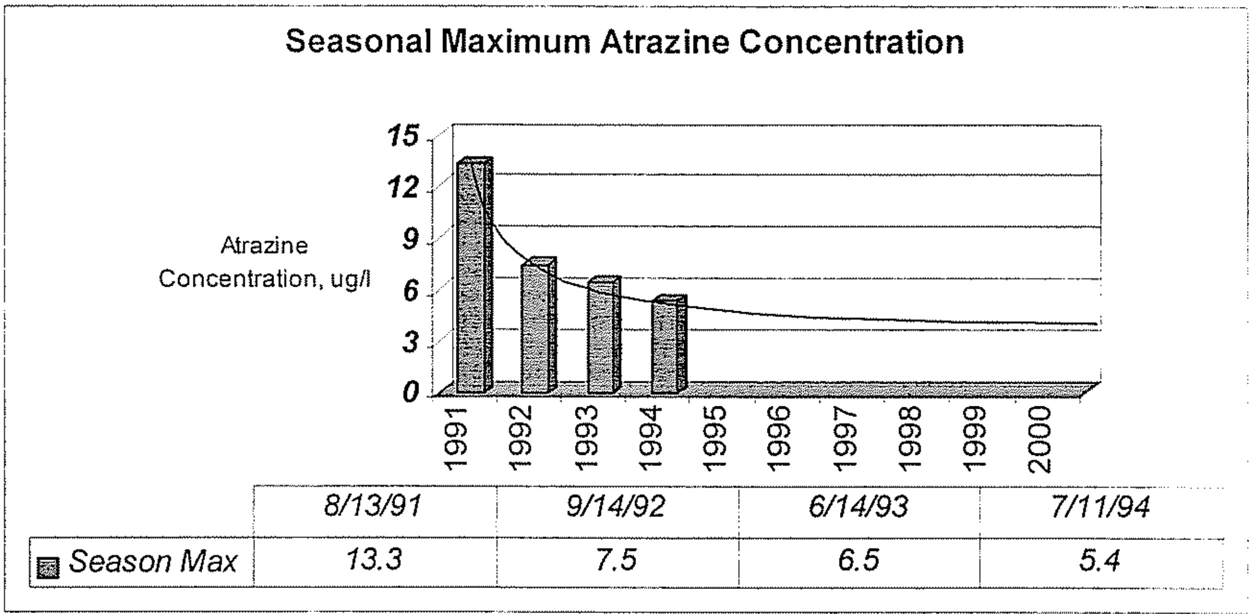

Figure 1. Observed seasonal maximum values extrapolated to 2000 to predict 1999 seasonal maximum value.

Since the study, several terraces, approximately 50,000 feet, have been constructed within the watershed (Sitzman, 2000). The improvements made to this watershed in the early 1990's were part of a demonstration project. This project involved various local, state and federal agencies, and most importantly local citizens. The fields have grass waterways that filter overland runoff prior to it entering the streams that flow into the reservoir. The land owners are applying less atrazine to their fields, and some land owners practice no till on their fields (EPA, 3/2000).

The Natural Resource Conservation Service has designated the majority of the land within the watershed is Highly Erodible Land (HEL). Several of the farmers have installed drainage tile systems. The tile outlets discharge directly into the streams that feed Corydon Reservoir. At least one tile outlet is discharged into a wetland. In a majority of the fields a small buffer strip is left along the streams.

The watershed was modeled using EPAs Screening Procedures to predict the current concentrations of dissolved atrazine in the reservoir (EPA, 1985). The screening procedure uses the Universal Soil Loss equation, the Soil Conservation Service's Curve Number equation and a first-order decay rate equation for pesticides to determine the amount of pesticide in the runoff that enters the waterbody. From this information the in lake concentrations can be calculated (see appendixes I for model input). The model was calibrated using the USGS study from 1990-94. The observed seasonal average values were plotted along with the modeled seasonal averages for 1991-1999, see figure 2. The Modeled values correlate with the extrapolated seasonal maximum values to indicate the modeled predictions are reasonable.

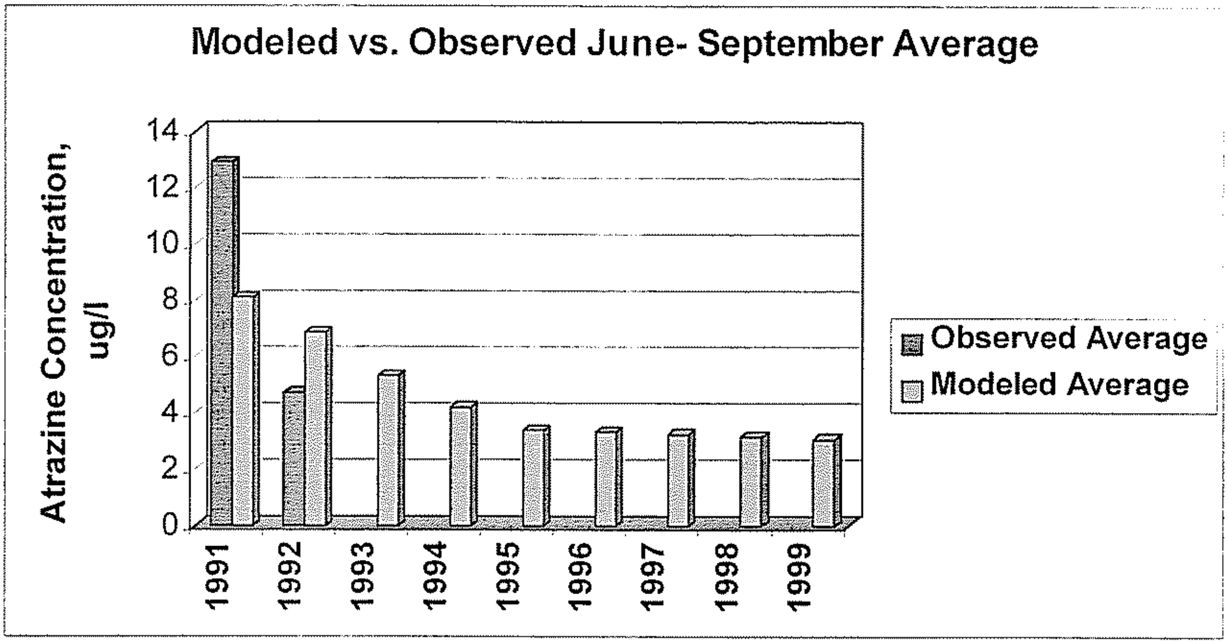

Figure 2. Modeled seasonal averages predict the 1999 average to be 3.04 µg/l.

Based on the implementation of best management practices (BMPs) in the watershed and current atrazine application rates, the average modeled atrazine concentration for June through September, 1999 is 3.04 µg/l (Sitzman 1996 & 2000). Because the model uses conservative assumption and without having exact atrazine application rates and dates, the water body may be meeting Water Quality Standards (WQS); but the decision of impairment needs to be based on monitored results rather than modeled. This TMDL will therefore, employ the phased approach. An "up front" monitoring plan should be established for the reservoir, and data collected before further BMPs are implemented.

The desired endpoint is to achieve the acute water quality standard[1] of 3 µg/l.

3. Source Assessment

The source of atrazine is from agricultural runoff in the watershed. As discussed above, the watershed is 52% row crop with about 335 acres of corn and about 540 acres of soy beans. The remaining area of the watershed is pasture and hayland (43%) and woodlands (4%)

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[1]This TMDL can be reopened if the State adopts and EPA approves a different Water Quality Standard for atrazine.

(Sitzman, 2000). Atrazine is typically applied to corn fields pre emergent, but can be applied post emergent. Corn is generally planted the end of April through mid May, depending on the weather conditions (EPA, 2000). The effectiveness of the installed BMPs is essentially what was modeled, since all things were held constant from modeled year to modeled year, except implemented BMPs. The input parameter that change from year to year, are SCS Curve number (which indicates landuse practices), atrazine application amounts in grams/hectare and acres of corn, see table 1.

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999
Corn Acres	400	392	384	376	368	360	352	344	335
SCS Curve #	90	89	87	85	83	83	83	83	83
Amount of Atrazine Applied (g/ha)	4484	3756	3027	2298	1570	1514	1457	1400	1345

Table 1. Model input values for 1991-1999. Values are based on implementation on Best Management Practices.

4. Load Capacity

The Load Capacity is a weighted average of 2.70 pounds of atrazine during June through September, the critical conditions (Kalkhoff, 1993). The reservoir is full in June, 98% full in July, 95% full in August and 92% full in September. The seasonal average volume of the reservoir is 332 acre-feet.

5. Pollutant Allocation Responsibility

Waste Load Allocation

Since there are no point source contributions of atrazine in the watershed the Waste Load Allocation will be zero.

Load Allocation

The current loading is estimated to be 2.74 pounds. The atrazine loading needs to be reduced by 11% to meet WQS. The Load Allocation is 2.43 pounds per year. This allocation is the total load to the lake during the year from non point sources. Based on the conservative nature of the model, the impairment needs to be further defined through monitoring. Therefore, this TMDL will use the phased approach. An "up front" monitoring program will be implemented, and when the data has been collected the water quality will be reassessed. If the reservoir is not meeting Water Quality Standards for atrazine, then more BMPs will be implemented throughout the watershed.

6. Margin of Safety

The margin of safety is 10% of the Load Capacity. The margin of safety is 0.27 pounds per year. Conservative assumptions were used in the input to the model which also contributes to the margin of safety, so the margin of safety is slightly more then 0.27 pounds.

7. Monitoring

It is recommended that the State or local watershed group monitor the reservoir for atrazine for a minimum of two years to determine the current condition of water quality. If one of the sampling years is unseasonably wet or dry, then a third year needs to be added to the monitoring plan. The reservoir should be assessed at least monthly during spring and fall, and weekly during the period of atrazine application. It is necessary to monitor more frequently during this time since atrazine is typically applied pre emergent. Also there is a greater chance of runoff due to the increase in precipitation. This monitoring effort needs to follow the state's approved Quality Management Plan. If this water quality monitoring is implemented by the watershed group, the approved monitoring plan needs to include a provision for the raw data to be submitted to the State for their review.

8. Implementation

The Rathbun Land and Water Alliance (RLWA), has developed a plan to improve water quality in Corydon Reservoir, since it is in the upper reaches of the Rathbun Reservoir Watershed. Members of RLWA include, Rathbun Regional Water Association, County Soil and Water Conservation Districts, Land owners, Natural Resource Conservation Service and USGS. This plan includes monitoring and installation of BMPs, if necessary. The RLWA will begin monitoring the lake prior to any land application of herbicides in 2000. The monitoring will continue for three years. After the three-year monitoring program the State will determine the level of impairment, if indeed it is impaired, and the Alliance will determine appropriate BMPs that should be installed if necessary.

The watershed group has applied for a Clean Water Act section 319 grant from the state to fund the project. A private company has also offered to donate sampling kits to the group for the monitoring.

An alternate model scenario was run assuming 50% of the corn crop was planted in the terraced fields each year. This scenario predicted in lake atrazine concentrations to be lower then the 1999 run prediction. Planning crop rotation to insure a portion of the corn crop is planted in the terraced fields will likely reduce the atrazine loading to the reservoir. Another suggested BMP that could be implemented while the monitoring is being conducted is to increase buffer strip area. Buffer strips may improve all aspects of water quality in Corydon Reservoir, by filtering out sediment, atrazine, nutrient and other agricultural chemicals.

8. Public Participation

A public meetings was held March 9, 2000, at the community building in Corydon to discuss the aspects of TMDLs, the data used in this TMDL, and the implementation of this TMDL.

Reference Used

Chapra, Steven C. 1997. Surface Water-Quality Modeling

EPA. 1985. Water Quality Assessment: A screen procedure for toxic and conventional pollutants in surface and ground water- Parts I & II: EPA 600/6-85/002a &b.

EPA. March 9, 2000. Conversation among EPA technical staff and members of the Rathbun Land and Water Alliance.

EPA. April 19, 2000. Comments received at the Technical meeting in Des Moines

*Foster, George R. (Editor). 1977. Soil Erosion: Prediction and Control

*Grover, Raj and Allan J. Cessna. 1988. Environmental Chemistry of Herbicides, Volume II.

*Haith, Douglas A., et al. February 1981. Watershed Loading Functions for Nonpoint Sources; Journal of the Environmental Engineering Division

Kalkhoff Stephen J. 1993. Water Quality of Corydon Reservoir Before Implementation of Agricultural Best-Management Practices in the Basin, Wayne County, Iowa, September 1990 to September 1991; USGS report 93-4099.

Rathbun Land and Water Alliance. No date: Rathbun Land and Water Alliance- Strategic Plan.

Sitzman, Vince. June 1996. Corydon Lake Water Quality Final Report, 1990-1995; Iowa Department of Agriculture and Land Stewardship.

Sitzman, Vince. March 2000. Corydon Lake Water Quality Proposal; Iowa Department of Agriculture and Land Stewardship.

Sitzman, Vince. April, 25 2000. E-mail on atrazine application rates in 1991 and 1999.

Sitzman, Vince. April, 26 2000. Conversation record on atrazine application dates in 1999.

US Department of Agriculture. 1971. Soil Survey, Wayne County, Iowa.

* Indicates the sources were used in the input into the Screening Procedures Model.

Appendix I

Model Input

Constants and parameters used in the EPA Screening Procedures Model

All equations are taken from Water Quality Assessment: A screen procedure for toxic and conventional pollutants in surface and ground water- Parts I & II: EPA 600/6-85/002a &b, September 1985.

Runoff (pages152-156)

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \qquad \text{For } P \geq 0.25$$

P= Precipitation, cm Used: Daily USGS data for water year 1991, and daily data received from IA Ag Dept for 1990-19983

S= Water retention

S=(2540/CN)-25.4 CN values can be found on page 155

Used: see table 1

Pesticide (Pages 190-207)

$$P_t = P_o \exp(-k_s t) + \Delta P_t$$

$$P_t = P_\tau^+ \exp[-k_s 9t - \tau)] + \Delta P_t$$

$$D_t = [1/(1 + K_D b / w)] P_t$$

$$A_t = [1/(1 + w / K_D b)] P_t$$

$$P_\tau^+ = P_t - PX_t - [1 - w / R_t] D_t$$

P_o= Amount of Pesticide applied (grams/ hectare) see Sitzman, 2000.

Used: see table 1

k_s = Decay rate (day^{-1})

Used: In Soil= **0.042** see Page 198

In Water= **0.01** see Grover, 1988

τ= addition of more pesticide or storm event on some day τ

w= available water capacity (cm/cm) values on page 195 (conservative value) Used: **0.22**

b=Bulk density (g/cm^3) values on page 195 (based on soil types, conservative value) Used: **1.33**

K_D= pesticide partition coefficient (l/kg)

K_D= K_{OC}(%OC/100) value given on page 206 = **2.89**

Conversion factors

1 m^3 = 1000 l	1 lb = 453.6 g	1 acre = 0.4047 ha	1 ft^3 = 0.02832 $m^3$1
lb/acre = 1.121 kg/ha	1g = 1,000,000 μg	1 inch = 2.54 cm	